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Thick-skinned tectonics in a Late Cretaceous-Neogene intracontinental belt (High Atlas Mountains, Morocco): The flat-ramp fault control on basement shortening and cover folding

A. Fekkak [a], H. Ouanaimi [b], A. Michard [c, *], A. Soulaimani [d], E.M. Ettachfini [a], I. Berrada [a], H. El Arabi [e], A. Lagnaoui [f], O. Saddiqi [e]

[a] Department of Geology, Faculty of Sciences, Chouaib Doukkali University, BP. 20, 24000, El Jadida, Morocco
[b] EGE, Department of Geology, Ecole Normale Supérieure, Cadi Ayyad University, BP S2400, Marrakech, Morocco
[c] Em. University Paris-Sud, 10 rue des Jeûneurs, 75002, Paris, France
[d] Department of Geology, Faculty of Sciences-Semlalia, Cadi Ayyad University, P.O. Box 2390, Marrakech, Morocco
[e] Department of Geology, Faculty of Sciences Ain Chock, Hassan II University, B.P. 5366, Maârif, Casablanca, Morocco
[f] Department of Paleontology and Stratigraphy, Institute of Geology and Petroleum Technologies, Kazan (Volga Region) Federal University, Kremlyovskaya str. 18, 420008, Kazan, Russia

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ABSTRACT

Most of the structural studies of the intracontinental High Atlas belt of Morocco have dealt with the central part of the belt, whose basement does not crop out. Here we study the Alpine deformation of the North Subatlas Zone, which is the part of the Western High Atlas (WHA) Paleozoic Massif that involves both Paleozoic basement units and remnants of their Mesozoic-Cenozoic cover formations. Our aim is to better constrain the geometry and kinematics of the basement faults during the Alpine shortening. Based on detail mapping, satellite imagery and field observations, we describe an array of sub-equatorial, transverse and oblique faults between the WHA Axial Zone and the Haouz Neogene basin. They define a mosaic of basement blocks pushed upon one another and upon the Haouz basement along the North Atlas Fault (NAF). The Axial Zone makes up the hanging-wall of the Adassil-Medinet Fault (AMF) south of this mosaic. The faults generally presents flat-ramp-flat geometry linked to the activation of multiple décollement levels, either within the basement where its foliation is subhorizontal or within favourable cover formations (Jurassic evaporites, Lower Cretaceous silty red beds, Upper Cretaceous evaporitic marls, Neogene basal argillites). The occurrence of the North Atlas detachment (NAD) allowed folded pop-up units to develop in front of the propagating NAF. Shortening began as early as the Campanian-Maastrichtian along the AMF. The direction of the maximum horizontal stress rotated from NNE-SSW to NNW-SSE from the Maastrichtian-Paleocene to the Neogene. The amount of shortening reaches 20% in the Azegour transect. This compares with the shortening amount published for the central-eastern High Atlas, suggesting that similar structures characterize the Paleozoic basement all along the belt. The WHA thick-skinned tectonics evokes that of the frontal Sevier belt and of the external Western Alps, although with a much minor pre-inversion burial.

1. Introduction

The 2000 km-long Atlas System extends from the Atlantic coast of Morocco to Tunisia (Fig. 1A). This Mesozoic-Cenozoic orogenic system includes intracontinental, double-verging fold belts and tabular, rhomboidal "mesetas" or plateaus. The Atlas System is overthrust in the north by the Alpine-type Maghrebide belt (Rif-Tell-Kabylias), and bounded in the south by the Sahara Platform. Morocco has the highest segment of the Atlas System, i.e., the High Atlas, whose most scenic part is the Marrakech High Atlas (MHA, Fig. 1B), which includes the highest peak of North Africa (Jebel Toubkal, 4167 m a.s.l.). The area attracted the earliest geological study ever performed in Morocco and published in 1878 (see historical review by Missenard et al., 2008). The intracontinental

* Corresponding author.
E-mail address: andremichard@orange.fr (A. Michard).

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